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Serum, Blood, and Breath Alcohol Results in a Case of  
Impaired Driving Causing Bodily Harm

by

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## CASE REPORT

### SERUM, BLOOD, AND BREATH ALCOHOL RESULTS IN A CASE OF IMPAIRED DRIVING CAUSING BODILY HARM

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#### ABSTRACT

A case report is presented in which a drinking driver who was involved in a serious single motor collision had blood samples collected at a hospital for medical purposes and later had breath samples collected and analysed by the Intoxilyzer<sup>®</sup> 5000C. The results of the serum alcohol analysis conducted by the hospital, the blood alcohol analysis conducted at the Centre of Forensic Sciences and the breath samples analysed by the Intoxilyzer<sup>®</sup> 5000C all showed close agreement. The estimated blood alcohol concentration at the time of the collision was calculated to be between 130 and 170 milligrams of alcohol in 100 millilitres of blood. The driver was convicted of impaired driving causing bodily harm and driving with a blood alcohol concentration of over 80 milligrams of alcohol in 100 millilitres of blood.

#### RÉSUMÉ

Une observation est présentée dans laquelle des échantillons sanguins ont été prélevés à des fins médicales sur un conducteur ivre impliqué dans un sérieux accident mettant en cause un seul véhicule. Des échantillons d'haleine ont par la suite été prélevés sur le même individu et analysés par l'Intoxilyzer<sup>®</sup> 5000C. Les résultats des analyses d'alcool dans le sérum effectuées à l'hôpital, les résultats des analyses d'alcool dans le sang effectuées au Centre des sciences judiciaires et les résultats des analyses d'alcool dans d'haleine effectuées à l'aide de l'Intoxilyzer<sup>®</sup> 5000C ont démontré une bonne corrélation. L'alcoolémie estimée au moment de la collision se situait entre 130 et 170 milligrammes d'alcool par 100 millilitres de sang. Le conducteur a été reconnu coupable de capacité de conduite affaiblie causant des lésions corporelles ainsi que d'avoir conduit avec une alcoolémie dépassant 80 milligrammes par 100 millilitres de sang.

#### INTRODUCTION

The blood alcohol concentration (BAC) of an arrested drinking driver is usually determined in Ontario by conducting an evidential breath test. If the driver is injured and receives medical treatment, blood samples collected for medical purposes can be seized by the police to be analysed at a later date at a forensic laboratory. Additionally, the hospital clinical laboratory records can be seized and interpreted for the court by a forensic alcohol toxicologist. An alcohol analysis is usually conducted at the hospital to determine if alcohol could affect the treatment of the injured driver (1, 2). In this unusual case

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report all three methods of determining the blood alcohol concentration of the driver were conducted.

## CASE HISTORY

A 22-year-old male weighing 105 kilograms (231 pounds) and 188 centimeters (six foot, two inches) in height attended a bush party in southwestern Ontario. A bush party is a gathering of young people, in a field, in which excessive drinking can occur (3). The local name of this bush party was “Pukefest” and admission was charged. The male was observed to have consumed bottled beer [5% v/v alcohol, 341 millilitre (12 fluid ounce) bottles] between 9:00 p.m. and approximately 5:00 a.m. the next morning. He was operating a motor vehicle with five young passengers who were at the bush party, and at 8:45 a.m. he was involved in a serious single motor vehicle collision in which the motor vehicle crossed the centre line of the roadway, went off the roadway and rolled over several times in a ditch. Two occupants of the motor vehicle were seriously injured and were transported to hospital. The four other people in the motor vehicle (including the driver) had minor injuries.

The police arrived at the scene of the crash at approximately 9:10 a.m. and interviewed the driver. The driver stated that he had “a couple of beers, not that much”. After observing several physical signs of alcohol intoxication and the smell of an alcohol beverage on the breath of the driver, the police arrested him for impaired driving. The driver was taken to hospital for medical treatment. Blood samples were collected at hospital at 11:15 a.m. and an alcohol analysis was conducted by the hospital. One of the blood samples collected at the hospital was seized by the police and sent to the Centre of Forensic Sciences in Toronto for alcohol analysis. In addition, at 12:43 p.m. and 1:03 p.m., Intoxilyzer® 5000C tests were conducted on the driver. During an interview at the hospital the driver admitted to consuming nine bottles of beer at the bush party.

## RESULTS AND DISCUSSION

An alcohol analysis was conducted at the hospital on the serum and the result was reported as 30.2 millimoles per litre (mmol/L). The method used at the hospital was an enzymatic method in which the alcohol concentration is measured by the enzymatic formation of NADH from NAD<sup>+</sup> during the oxidation of the alcohol in the sample (4, 5). The serum alcohol concentration of 30.2 mmol/L is equivalent to 139 milligrams of alcohol in 100 millilitres of serum. This conversion is accomplished by using the molecular weight of alcohol (46.07 grams/mole). As the statutory limit for driving in the Criminal Code of Canada is in the units of milligrams of alcohol in 100 millilitres of blood, for court purposes the serum alcohol has to be converted into a blood alcohol concentration. Various studies have shown that the serum (or plasma)/blood alcohol concentration ratio, can range from 1.04:1 to 1.26:1 (6, 7, 8) and the mean ratio can vary 1.11 to 1.14:1. The ratio usually employed at the Centre of Forensic Sciences is 1.16:1, as this ratio would tend to underestimate the BAC. Using this ratio the blood alcohol concentration, as determined by the hospital, was equivalent to 120 milligrams of alcohol in 100 millilitres of blood (mg/100mL).

A sealed lavender top BD Vacutainer™ containing whole blood from the driver was received at the Centre of Forensic Sciences twelve days after it was collected. The sample was stored at 4°C until it was analysed one month later. The blood was analysed by head-space gas chromatography using t-butanol as an internal standard (9). The blood alcohol concentration was 116 mg/100mL. This is in close agreement with the hospital result. The only other volatile substance detected in the sample was acetaldehyde, which was present in trace amounts.

BD Vacutainers™, which are commonly used in hospitals for the collection of blood samples, have their tops colour coded to indicate which additives are contained within the tube. The lavender top tubes contain the anticoagulant K<sub>3</sub>EDTA (potassium ethylene diamine tetraacetic acid) and are used for whole blood hematology determinations. A list of some of the common Vacutainers™ that have been seized by the police in Ontario are shown in Table 1 (10). None of the additives listed would affect the result of the headspace gas chromatographic analysis for alcohol.

The stability of the alcohol in seized blood samples is occasionally raised as an issue in court, especially when the Vacutainers™ do not contain sodium fluoride as a preservative, as in this case. Although postmortem samples can have large increases in blood alcohol concentration due to microbial decomposition, these increases are unlikely to occur in blood samples collected from living subjects. Blood from a living subject is virtually sterile, unlike postmortem samples (11). In addition, the blood glucose (a major substrate for microbial fermentation of alcohol) concentration is much lower in blood from living subjects compared to postmortem blood. Postmortem blood has been found to contain up to 1200 mg/100mL glucose (12, 13) whereas blood in living non-diabetic subjects is usually approximately 100 mg/100mL glucose (14). The possibility of microbial fermentation of glucose in stored blood samples from living subjects is further limited in that the glucose concentration rapidly decreases during storage due to the anaerobic catabolism of glucose by erythrocytes (15,16).

In this particular case, the lack of other volatile substances such as n-propanol, which could indicate microbial changes in the blood alcohol concentration (9,11), and the close agreement with the hospital result further preclude the possibility of any significant changes in alcohol concentration of the seized blood sample during storage.

The truncated Intoxilyzer® 5000C test results were 90 and 90 mg/100mL at 12:43 p.m. and 1:03 p.m. respectively. The breath alcohol results are lower than the alcohol concentration determined in the blood. This is due to the elimination of alcohol that occurred during the time between the collection of the blood and breath samples (approximately 1.5 hours). Additionally, the Intoxilyzer® 5000 has been found to have a tendency to underestimate the blood alcohol concentration mainly due to the blood/breath alcohol ratio to which the instrument is calibrated (17).

The BAC of the driver at the time of the motor vehicle collision can be estimated from these three results (Table 2). The long period of time over which the beer was consumed, and the nearly four hours between the time the beer was last consumed and the time of the collision indicate that the driver's BAC was in the linear decline phase at the time of the collision (18,19). Therefore, the estimated BAC at the time of the collision can be determined by using the time between the collision and the time the samples were collected and a rate of alcohol elimination of between 10 and 20 mg/100mL/h (20). As shown in Table 2 the estimated BAC at the time of driving ranges from 130 to 170 mg/100mL. At this BAC range, numerous studies have shown that there would be impairment of various functions required for the safe operation of a motor vehicle (21–24).

The amount of beer that would have to have been consumed can also be calculated using the standard Widmark equation (25). Assuming the driver was alcohol-free at the start of drinking at 9:00 p.m., the driver would have had to consume approximately 13 to 20 bottles of beer to obtain an estimated BAC of 130 mg/100mL at the time of the collision. This is in contrast to the driver's self-reported consumption of 'a couple of beers' mentioned at the scene and the 'nine bottles' at hospital. Underreporting of the amount of alcohol consumed is common in drinking drivers (26).

**TABLE 1**  
**Common hospital tubes seized by the police in Ontario for forensic blood alcohol determination**

Colour of the top of BD Vacutainer™ Tubes With Hemogard™ Closure	Additive	Clinical Use
Gold	Clot activator and gel for serum separation	Serum determinations in chemistry
Red	None (glass tube) Clot activator (plastic tube)	Serum determinations in chemistry and serology
Green	Sodium heparin Lithium heparin	Plasma determinations in chemistry
Grey	Potassium oxalate/ sodium fluoride Sodium fluoride/ Na <sub>2</sub> EDTA Sodium fluoride (serum tube)	Glucose determinations
Royal Blue	Sodium heparin Na <sub>2</sub> EDTA None (serum tube)	Trace element, toxicology and nutritional chemistry determinations
Lavender	Liquid K <sub>3</sub> EDTA (glass) Spray-dried K <sub>2</sub> EDTA (plastic)	Whole blood hematology determinations

**TABLE 2**  
**Estimated blood alcohol concentration of the driver at the time of the collision (8:45 a.m.) based on the three different samples analysed and the reported drinking pattern**

Blood alcohol Sample	Concentration (mg/100mL)	Estimated BAC Time of collection	(mg/100mL) at 8:45 a.m.
Serum	120	11:15 a.m.	145 to 170
Blood	116	11:15 a.m.	141 to 166
Breath	90	12:43 p.m.	130 to 170

Although the legal decision in this case is not important to the science, the driver was convicted of impaired driving causing body harm and driving with a BAC in excess of 80 mg/100mL.

## CONCLUSION

This case report illustrates three different methods of determining the blood alcohol concentration of a drinking driver. The close agreement between the hospital analysis of the serum sample and the blood alcohol analysis at the forensic laboratory and the Intoxilyzer® 5000C results indicate that alcohol analyses are, in general, robust techniques.

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